

What Is Claimed Is:

1. A method of multi-resolution vector quantization for audio encoding, characterized in that it comprises the steps of: adaptively filtering an input audio signal so as to gain a time-frequency filter coefficient and outputting a filtered signal; dividing vectors of the filtered signal in a time-frequency plane so as to gain a vector combination; selecting vectors to be quantized; quantizing the selected vectors and calculating a residual error of quantization; and transmitting a quantized codebook information as a side-information of an encoder to an audio decoder to quantize and encode the residual error of quantization.
2. The method of multi-resolution vector quantization for audio encoding of claim 1, wherein the procedure of said adaptively filtering an audio signal further comprises: decomposing the input audio signal into frames and calculating a transient measure of a signal frame; discriminating whether a type of a current signal frame is a graded signal or a fast-varying signal by comparing a value of the transient measure with a value of a threshold; if it is the graded signal, then proceeding a cosine modulation filtering with equal bandwidth to gain a filter coefficient in a time-frequency plane and output the filtered signal; if it is a fast-varying signal, then proceeding a cosine modulation filtering with equal bandwidth to gain a filter coefficient in a time-frequency plane, analyzing the filter coefficient in multi-resolution by a wavelet transform, adjusting a time-frequency resolution of the filter coefficient, and finally outputting the filtered signal.
3. The method of multi-resolution vector quantization for audio encoding of claim 2, wherein the cosine modulation filtering adopts a traditional cosine modulation filtering or a modified discrete cosine transform filtering.
4. The method of multi-resolution vector quantization for audio encoding of claim 3, wherein the cosine modulation filtering further comprises a Fast Fourier Transform.

5. The method of multi-resolution vector quantization for audio encoding of claim
2, wherein if it is the fast-varying signal, the procedure further comprises: subdividing
the fast-varying signal into the fast-varying signal of various types and processing
filtering and multi-resolution analysis respectively for different types of the fast-varying
5 signal.

6. The method of multi-resolution vector quantization for audio encoding of claim
5, wherein a wavelet base of a wavelet transform during said processing
multi-resolution analysis is fixed or adaptive for different types of the fast-varying
signal.

10 7. The method of multi-resolution vector quantization for audio encoding of claim
1, wherein dividing vectors of the filtered signal in a time-frequency plane includes
three methods: dividing in a time direction, in a frequency direction and in a
time-frequency area;

15 said dividing in a time direction further includes keeping a resolution in the
frequency direction unvaried and dividing time so as to make the number of divided
vectors to be N/D and gain a I type vector array, wherein N means a length of a
frequency coefficient of the audio signal, and D means dimensions of a vector;

20 said dividing in frequency direction further includes keeping a resolution in the
time direction unvaried and dividing a frequency to make the number of divided
vectors to be N/D and gain a II type vector array, wherein N means a length of a
frequency coefficient of the audio signal, and D means dimensions of a vector;

25 said dividing in time-frequency area further includes dividing time and a frequency
in the time-frequency plane to make the number of divided vectors to be N/D and gain
a III type vector array, wherein N means a length of a frequency coefficient of the audio
signal, and D means dimensions of a vector;

8. The method of multi-resolution vector quantization for audio encoding of claim
1, wherein the procedure of said selecting vectors to be quantized further includes:

discriminating whether it is necessary to quantize all the vectors in the time-frequency plane, if yes, respectively calculating quantization gains of a I type vector array, a II type vector array and a III type vector array and selecting vectors in the vector array with a largest value of the quantization gain as the vectors to be quantized; else

5 selecting M vectors to be quantized and encoding serial numbers of selected vectors.

9. The method of multi-resolution vector quantization for audio encoding of claim 8, wherein the procedure of said selecting M vectors to be quantized further includes: forming a vector aggregate from the vectors in the I type vector array, the II type vector array and the III type vector array; calculating an energy of each vector in said vector aggregate, i.e. square of the coefficient, as well as calculating a variance of each component of each vector sorting the vectors in the vector aggregate by the energy from the biggest to the smallest; re-sorting the above sorted vectors by the variance from the smallest to the biggest; determining the number M of vectors to be selected according to the ratio of a total energy of the signal to the total energy of the currently

10 selected vectors, and selecting first M vectors to be the vectors to be quantized; if the vectors in a same area are included in the I type vector array, the II type vector array and the III type vector array at the same time making selection according to the ordering of the variance.

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10. The method of multi-resolution vector quantization for audio encoding of claim 8, wherein the procedure of said selecting M vectors to be quantized further includes: forming a vector aggregate from the vectors of the I type vector array, the II type vector array and the III type vector array ; calculating an energy of each vector in said vector aggregate and an encoding gain; selecting a first M vectors with the biggest encoding gain to make the energy of the selected M vectors over 50% of a

20 total energy.

11. The method of multi-resolution vector quantization for audio encoding of claim 9 or 10, wherein a numerical value of said M can be any integer from 3 to 50.

12. The method of multi-resolution vector quantization for audio encoding of claim 1, wherein the procedure of said quantizing the selected vectors further comprises: calculating an energy value of each area of the time-frequency plane or a absolute maximum; defining a global normalization factor; normalizing the selected vectors; 5 calculating a local normalization factor of the vector and normalizing at second time; quantizing normalized vectors and calculating a residual error of quantization.

13. The method of multi-resolution vector quantization for audio encoding of claim 12, wherein the procedure of said quantizing the selected vectors further comprises: calculating the energy value of each area of the time-frequency plane or the absolute 10 maximum ; forming a Unary Function $Y=f(X)$, wherein X represents a serial number of an area, and Y represents the energy or the absolute maximum corresponding to area X; defining a global gain according to the total energy of the signal and quantizing and encoding it by a logarithm model; normalizing the selected vectors by the global gain; calculating the local normalization factor of a current vector according to Taylor 15 Formula and normalizing the current vector once again; obtaining a general normalization factor of the current vector to be a product of the above two normalization factors; forming a M-dimensional vector by a function value of the selected M areas; calculating a first-order difference and a second-order difference corresponding to the vector; obtaining codebooks of the above three vectors by 20 Codebook Training Algorithm and quantizing the above three vectors; quantization of the vectors corresponding to a zero-order approximate expression of Taylor Formula, and adopting an Euclidean distance for a distortion measure in codebook searching; quantization of the vector of the first-order difference corresponding to a first-order approximation of Taylor Formula, searching a few code words with the least distortion 25 of the corresponding codebook according to the Euclidean distance, then calculating a quantization distortion of each area of a small neighborhood at the current vector x_0 , at last summing up the distortion to be the distortion measure; quantization of the

vector of the second-order difference being similar with the quantization of the vector of the first-order difference.

14. The method of multi-resolution vector quantization for audio encoding of claim 12, wherein the procedure of said quantizing the selected vectors further comprises:

5 calculating the energy value of each area of the time-frequency plane or the absolute maximum ; forming a Unary Function $Y=f(X)$, wherein X represents a serial number of an area, and Y represents the energy or the absolute maximum corresponding to area X; defining a global gain according to the total energy of the signal and quantizing and coding it by a logarithm model; normalizing the selected vectors by the global gain;

10 calculating the local normalization factor of a current vector according to a Spline Curve Fitting Formula and normalizing the current vector once again; forming a M-dimensional vector by a function value of the selected M areas and the vector being able to be decomposed into several component vectors which are called vectors of selected points; quantizing the above vectors separately.

15 15. A method of multi-resolution vector quantization for audio decoding, characterized in that it comprises the following steps of: demultiplexing a code stream to gain a side information of the multi-resolution vector quantization , an energy of a selected point and location information of vector quantization; inverse quantizing vectors to obtain a normalized vector according to the above information and

20 calculating a normalization factor to rebuild a quantized vector in an original time-frequency plane; adding the rebuilt vector to a residual error of a corresponding time-frequency coefficient according to the location information; obtaining a rebuilt audio signal by inverse filtering in multi-resolution and mapping from frequency to time.

16. The method of multi-resolution vector quantization for audio decoding of claim 15, wherein the step of said rebuilding a quantized vector in an original time-frequency plane further comprises: calculating an energy and values of each order difference of each selected point from a codebook according to the side information; obtaining the

location information of vector quantization in the time-frequency plane and a global normalization factor from the code stream; obtaining a normalization factor at second time in the corresponding position in accordance with a formula used in encoding process to calculate a normalization factor at second time; obtaining the normalized 5 vector according to a vector quantization index, multiplying the normalized vector with the above two normalization factors to rebuild a quantized vector in a time-frequency plane.

17. The method of multi-resolution vector quantization for audio decoding of claim 15, wherein the procedure of said inverse filtering in multi-resolution further comprises: 10 organizing a time-frequency for the time-frequency coefficient of the rebuilt vector, performing following filtering according to types of signals obtained from decoding: if it is a graded signal, proceeding a cosine modulation filtering with equal bandwidth to gain a pulse code modulation output in a time domain; if it is a fast-varying signal, integrating in multi-resolution and proceeding a cosine modulation filtering with equal 15 bandwidth to gain a pulse code modulation output in a time domain.

18. The method of multi-resolution vector quantization for audio decoding of claim 17, wherein the fast-varying signal can be further divided into various types of the fast-varying signal, integrating in multi-resolution and filtering are respectively performed to different types of the fast-varying signal.

20 19. A device of multi-resolution vector quantization for audio encoding, characterized in that it comprises: a time-frequency mapper, a multi-resolution filter, a multi-resolution vector quantizer, a psychological acoustic calculation module and a quantization encoder;

the time-frequency mapper for receiving an input audio signal to process mapping 25 from time to frequency domain and output to the multi-resolution filter;

the multi-resolution filter for adaptively filtering the signal, and outputting a filtered signal to the psychological acoustic calculation module and the multi-resolution vector

quantizer;

the multi-resolution vector quantizer for vector quantizing the filtered signal and calculating a residual error of quantization, transmitting a quantized signal as a side information to an audio decoder and outputting the residual error of quantization to the
5 quantization encoder;

the psychological acoustic calculation module for calculating a masking threshold of a psychological acoustic model according to the input audio signal, and outputting the masking threshold to the quantization encoder so as to control noise allowed in quantization ;

10 the quantization encoder for quantizing and entropy coding the residual error output by the multi-resolution vector quantizer to gain an encoded code stream information under restriction of the allowed noise output by the psychological acoustic calculation module.

20. The device of multi-resolution vector quantization for audio encoding of claim
15 19, wherein the multi-resolution filter comprises a transient measure calculation module, M equal bandwidth cosine modulation filters , N multi-resolution analyzing modules and time-frequency filter coefficient organization modules, and satisfying
 $M=N+1$;

the transient measure calculation module for calculating a transient measure of
20 an input audio signal frame to determine a type of the signal frame;

the equal bandwidth cosine modulation filters for filtering the signal to gain a filter coefficient; if the signal is a graded signal, outputting the filter coefficient to the time-frequency filter coefficient organization module; if the signal is a fast-varying signal, transmitting the filter coefficient to the multi-resolution analyzing module;

25 the multi-resolution analyzing module for performing wavelet transform to the filter coefficient of the fast-varying signal, adjusting a time-frequency resolution of the coefficient, outputting a transformed coefficient to the time-frequency filter coefficient

organization module;

the time-frequency filter coefficient organization module for organizing filtered output coefficients in a time-frequency plane and outputting the filtered signal.

21. The device of multi-resolution vector quantization for audio encoding of claim

5 19, wherein the multi-resolution vector quantizer comprises: a vector organization module, a vector selection module, a global normalization module, a local normalization module and a quantization module;

the vector organization module for organizing coefficients in the time-frequency plane output by the multi-resolution filter according to different dividing policies into a 10 vector form, and outputting the vector to the vector selection module;

the vector selection module for selecting vectors to be quantized according to energy etc factors, and outputting the vectors to be quantized to the global normalized module;

the global normalized module for globally normalizing the vectors;

15 the local normalized for calculating a local normalization factor of each vector locally normalizing vectors output by the global normalized module and outputting to the quantization module;

the quantization module for quantizing vectors which are normalized at twice, and calculating the residual error of quantization.

20 22. A device of multi-resolution vector quantization for audio decoding, characterized in that it comprises: a decoding and inverse-quantizing device, a multi-resolution inverse-vector quantizer, a multi-resolution inverse filter and a frequency-time mapper;

the decoding and inverse -quantizing device for demultiplexing , entropy decoding 25 and inverse -quantizing a code stream to obtain a side information and encoding data and outputting to the multi-resolution inverse-vector quantizer;

the multi-resolution inverse-vector quantizer for quantizing a inverse-vector to

rebuild a quantized vector, adding a rebuilt vector to a residual coefficient of a time-frequency plane and outputting to the multi-resolution inverse filter;

the multi-resolution inverse filter for inverse filtering the vector rebuilt by the multi-resolution vector quantizer and outputting to the frequency-time mapper;

5 the frequency-time mapper for mapping a signal from frequency to time to obtain a final rebuilt audio signal.

23. The device of multi-resolution vector quantization for audio decoding of claim 22, wherein the multi-resolution inverse-vector quantizer comprises: a demultiplexing module, an inverse-quantizing module, a normalized vector calculation module, a 10 vector rebuilding module and an addition module.

the demultiplexing module for demultiplexing a received code stream to obtain a normalization factor and a quantization index of a selected point;

the counter-quantized module for obtaining an energy envelope and location information of vector quantization according to the information output from the 15 demultiplexing module, inverse-quantizing to obtain a vector of a guide point and a selected point, calculating a second normalization factor and outputting to the normalized vector calculation module;

the normalized vector calculation module for inverse-normalizing the vector of the selected point to obtain a normalized vector, and outputting to the vector rebuilding 20 module;

the vector rebuilding module for inverse-normalizing the normalized vector once again according to the energy envelope to obtain the rebuilt vector;

the addition module for adding the rebuilt vector output from the vector rebuilding module to a residual error of inverse-quantization in the corresponding time-frequency 25 plane to obtain an inverse-quantized time-frequency coefficient as an input of the multi-resolution inverse filter.

24. The device of multi-resolution vector quantization for audio decoding of claim

22, wherein the multi-resolution inverse filter further comprises: a time-frequency coefficient organization module, N multi-resolution integration modules and M equal bandwidth cosine modulation filters , satisfying $M=N+1$;

the time-frequency coefficient organization module for organizing

5 inverse-quantized coefficients by filter input method, if a graded signal, inputting to the equal bandwidth cosine modulation filters ; if a fast-varying signal, outputting to the multi-resolution integration module;

the multi-resolution integration module for mapping a multi-resolution time-frequency coefficient to be a cosine modulation filter coefficient with equal

10 bandwidth, and outputting to the equal bandwidth cosine modulation filters;

the equal bandwidth cosine modulation filters for filtering the signal to obtain a pulse coding modulation output in time domain.